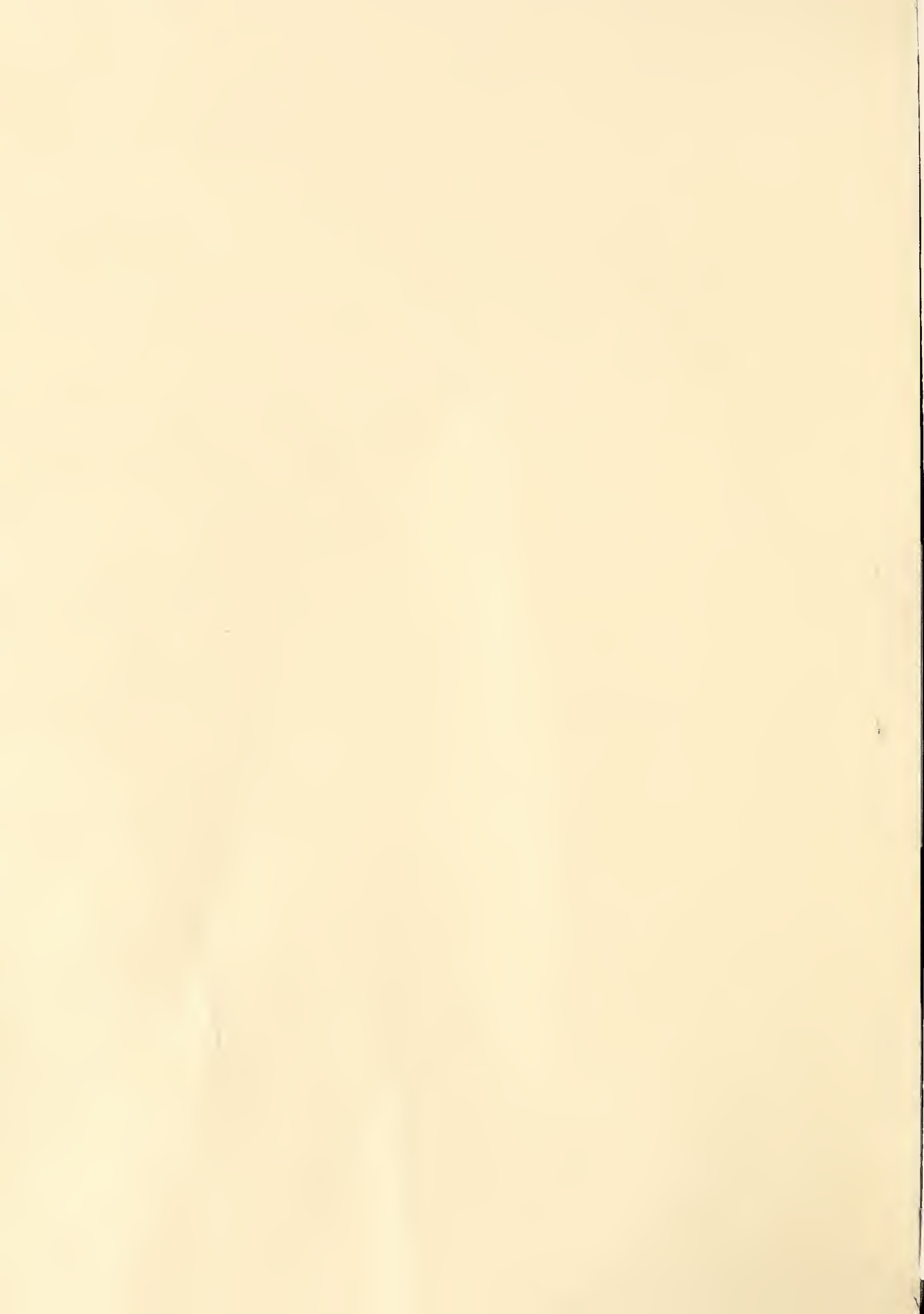
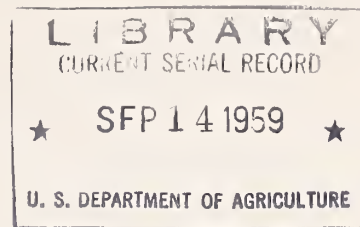


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SUCTION RECLAIMER FOR SHATTERED SEED

By

Leonard M. Klein and Jesse E. Harmond ^{1/}

INTRODUCTION

Seed losses due to field shattering are reducing U. S. farmers' revenue by several million dollars annually. Many grass and legume seeds shatter before the forage and seed are dry enough to combine; and other crops, such as subterranean clover, produce seed near the ground, making harvest difficult with conventional equipment. In a survey of some 65 seed harvesting operations in the Willamette Valley of Oregon during 1953 and 1954, average seed losses caused by shattering were found to be 31 percent for crimson clover, 26 percent for alta fescue, 25 percent for hairy vetch, and 68 percent for subterranean clover.

In an effort to salvage the shattered seed, agricultural engineers of the cooperative research project of the Oregon Agricultural Experiment Station and the Harvesting and Farm Processing Research Branch of the Agricultural Engineering Research Division, A.R.S., U.S.D.A., have developed a seed reclaimer.

A review of the literature^{2/} revealed that a number of investigators had constructed suction machines and attempted to recover shattered seed --with only partial success. Two chief objections reported were a high percentage of shattered seed left on the ground and a relatively low germination of reclaimed seed. It was concluded that the low recovery could be attributed to the fact that the suction operation was conducted without the aid of seed agitation, and that reduced germination was related to seed damage caused by seed passing through the suction fan.

After studying the problems and reports on seed harvesting methods and equipment, the agricultural engineers decided that the best possibilities for efficient seed recovery were offered by a suction-type reclaimer equipped with an agitator and a means of removing seed before it reached the fan.

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^{2/} Listed at end of report.

A preliminary investigation of this idea was made using a cylinder type household vacuum cleaner to reclaim shattered seed, such as crimson clover, bentgrass, subterranean clover, hairy vetch, and alta fescue, from the harvested field (Figure 1). It was found that the seeds could be salvaged 100 percent when they were agitated with the end of the suction hose, and the germination of reclaimed seed caught in the bag was comparable to the germination of hand-harvested seed.

RECLAIMER DEVELOPMENT

Based on this initial test and information found in the literature, a giant-size vacuum cleaner was designed and constructed in 1955 to reclaim shattered seed. The unit was mounted on a 2-wheel trailer and was tractor drawn. It consists of a seed agitator, suction nozzle, air-seed separator, clod-crushing rolls, rotary air-seal dropper, suction fan, and a gasoline engine plus the necessary flexible couplings and air ducts making up the air system from nozzle to fan (Figure 2). The unit was designed primarily for reclaiming shattered seed from fields with flat seedbeds, and with straw removed.



Figure 1. Reclaiming shattered seed with household vacuum cleaner; test truck and gas-electric generator in the background.



Figure 2. Side view of trailer type suction reclaimer for shattered seed. The suction fan can be seen in the rear and the nozzle to the front, the separator box in the upper center, and the gasoline engine in the lower center. The chain agitator can be seen to the left of the nozzle.

PRINCIPLE OF OPERATION

A floating nozzle, 6 feet wide, closely follows the ground contour and sucks up shattered seed and other loose material with the aid of a revolving chain or brush agitator.

Salvaged material flows through a sheet metal duct to an enlarged section, called the separator chamber, where it strikes a revolving screen. Air and fine dust particles go through the screen and are taken to a fan which discharges them to the atmosphere. The reclaimed seed, dirt clods, leaves, straw, and other material taken from the moving air by the revolving screen are doffed from the screen either by the clod-crushing rolls or the rubber tips on the air-seal discharge dropper. Many of the dirt clods and seed pods are crushed as they pass between the spring-loaded rolls. The air-seal rotary dropper then transfers doffed material from the separation chamber to a bin.

A second reclaimer has now been developed which utilizes the same components as the original. However, rather than being a separate unit, the new reclaimer is designed and constructed as an attachment to a combine, and material salvaged from the field is fed into the feed screw of the threshing cylinder. The unit is shown in Figure 2, and the attachment model in Figures 3 and 4.

The combine attachment has several advantages over the separate seed reclaimer.

1. No separate operator is required, as the man running the combine can also run the reclaimer.
2. It is propelled with the combine and does not require a separate tractor to pull the attachment as is the case with the separate unit.
3. The reclaimed seed does not require rehandling, as it is threshed along with the incoming seed crop that is being harvested.
4. It requires no preliminary removal of threshed straw from the field, since the nozzle is located below the combine, behind the cutter bar, and ahead of the straw discharge. In this location, the nozzle removes seed from the ground while the material cut from the field is in transit through the combine.

DESCRIPTION OF COMPONENTS

In the separate tractor-drawn unit, the ground agitator, air-seed separator, and fan are driven by a 30-hp. gasoline engine. The nozzle and ground agitator are mounted on a floating shoe which follows the field contour. A hydraulic system controlled by the tractor driver will raise the nozzle as much as 6 inches to give the necessary ground clearance when the unit is being moved from field to field.

The suction nozzle and ground agitator of the attachment model are mounted below the rear of the combine just ahead of the straw and chaff discharge. The fan, located on a trailer-drawn tandem with the combine, is driven by a 30-hp. gasoline engine; the ground agitator and air-seed separator are driven by a 5-hp. air-cooled gasoline engine mounted on top of the combine. If there is a need for ground clearance, the nozzle and agitator may be raised by the hydraulic control lever near the tractor seat.



Figure 3. Front view of combine with shattered seed suction reclaimer installed. The fan and power unit is on the right, the separator box and rotary dropper are in the upper center; the air duct leading to the suction nozzle can be seen on the left.



Figure 4. Rear view of the unit mounted on the combine. The suction nozzle and rotating agitator can be seen at the lower right beneath the combine and ahead of the threshed straw discharge. The suction fan and its gasoline engine are mounted on the trailer to the left.

Both the trailer unit and the combine attachment employ three main sections connected by air ducts: (1) Nozzle and agitator, (2) air-seed separator, and (3) fan and power unit. (See Diagram I.)

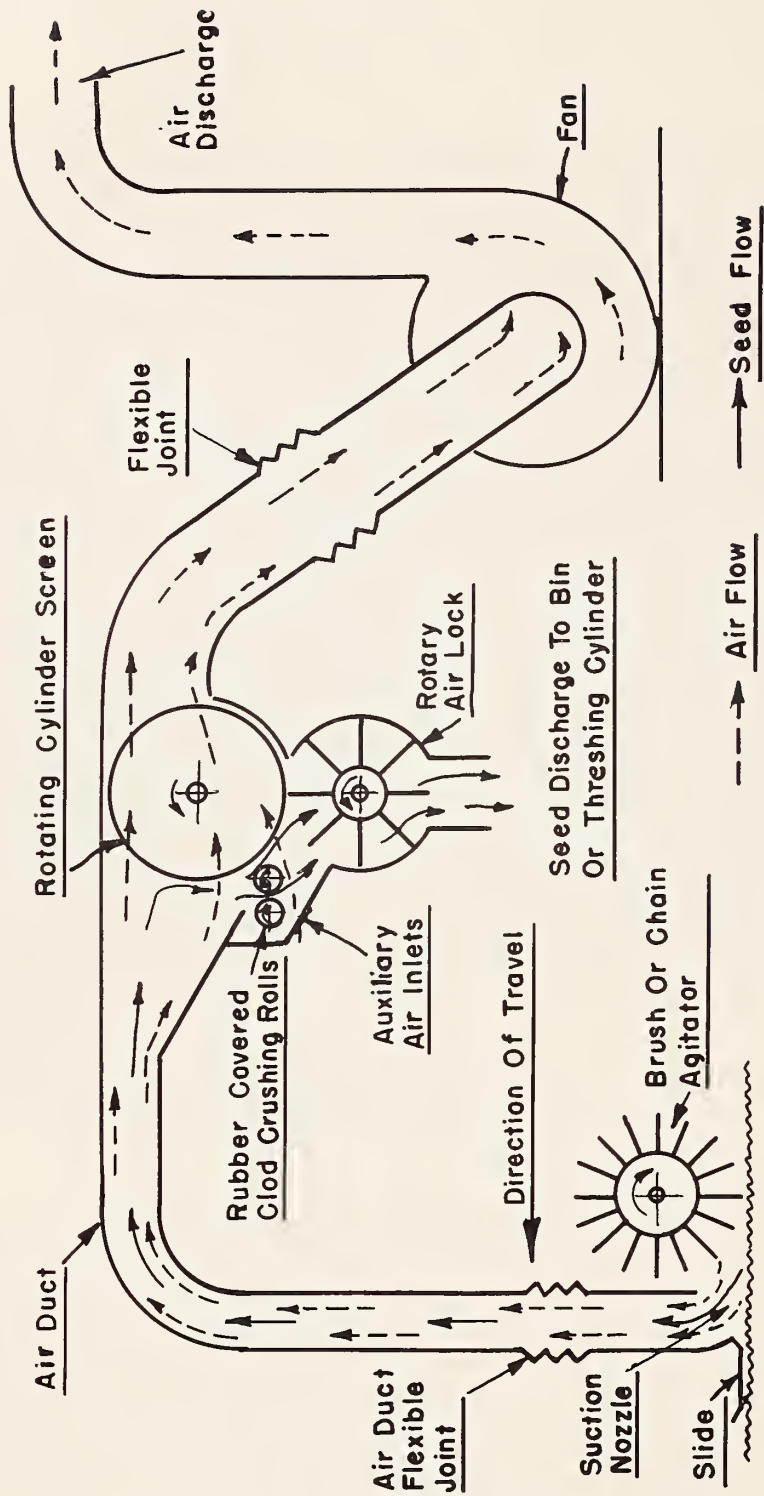
Nozzle and Agitator. The nozzle is a 4-inch by 6-foot duct made of sheet metal, which presents an opening at an angle of 45 degrees to the ground, and is supported by a metal slide in front the full width of the nozzle. In operation, the slide rides the ground and partially seals off the air flow to the nozzle; the air supply is thus directed through the agitator. A large portion of the free seed is picked up directly by the air as the nozzle passes over it. With the loose material removed from the ground, the agitator then dislodges the remaining seed, propelling it into the air stream to be conveyed. The floating action of the nozzle is made possible by a specially designed flexible air-duct joint. Plastic-covered woven fabric connects the nozzle to the stationary air duct and is held from collapsing by rectangular frames constructed of aluminum U-sections fastened to the outside of the plastic at 3-inch spacings. (See Diagram I.)

Two types of seed agitators are being used successfully in connection with the nozzle (See Diagram II). One is a 14-inch-diameter bassine fiber brush that gives excellent results on smooth ground but rides ridges and stubble to leave seed at these points in the field. It also fails to sweep seed out of the grain drill recesses. The other type is a 16-inch-diameter case harden, rotating-chain beater, which has several advantages over the brush. Its initial cost is less and its wear properties are better, it requires less power to operate, and seed is moved from the stubble or grain drill recesses while adjacent ground is being swept clean.

The agitator was tried first in front of the suction nozzle and then behind. The effectiveness of the agitator was increased approximately 10 percent when it was moved from the front to the back of the nozzle. This was due, in part, to the fact that the suction removed loose material from the field first, and the agitator then was required to handle only the small mass of material left on the ground rather than the entire volume of straw, seed, and leaves.

Air-Seed Separator. The air-seed separating unit is an enlarged section of the air duct which houses a rotating cylindrical screen, 24 inches in diameter, with holes smaller than the seed to be harvested, two 4-inch rubber-covered clod-crushing rolls, and a 16-inch-diameter, 12-bladed, rubber-tipped rotary air lock. (See Diagram I.) Seeds approaching this section from the nozzle strike the rotary screen and are "screened out" of the air stream. The clod-crushing rolls are located so as to receive the clods that drop from the screen. Dust produced by the rolls is picked up and carried through the lower part of the screen by air from auxiliary inlets. Seed adhering to the screen is brushed off by the rotary air lock blades and discharged.

SUCTION RECLAIMER SEED AND AIR FLOW DIAGRAM



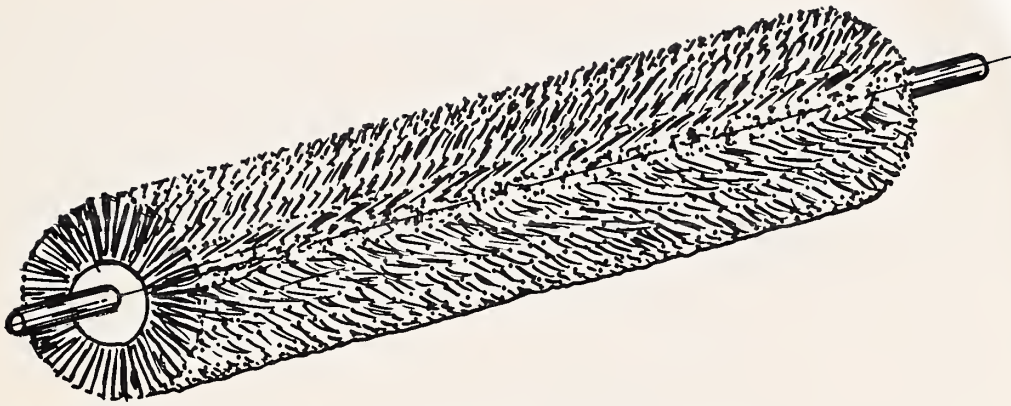
NOZZLE & AGITATOR

AIR-SEED SEPARATOR

FAN & POWER UNIT

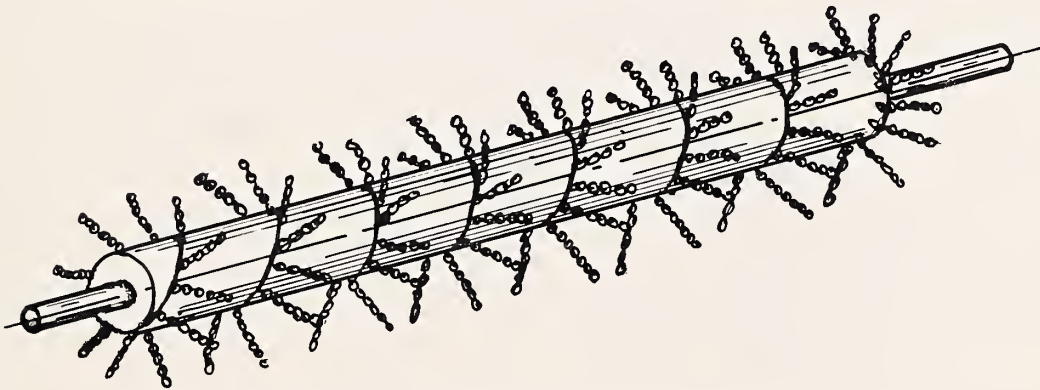
DIAGRAM I.

Air and Seed Flow diagram of Suction Reclaimer.



BASSINE FIBER BRUSH AGITATOR

14" O.D.
6" HUB
4" BRISTLES
72" LONG



ROTATING CHAIN AGITATOR

16" O.D.
3" HUB
6 1/2" CHAINS
DOUBLE SPIRAL SPACED 1" Laterally
72" LONG

DIAGRAM II

Rotary Brush and Chain Agitators used on the Suction Seed Reclaimer.

Fan and Power Unit. Dust-laden air from the screen is drawn through a sheet metal air duct to a 32-inch-diameter radial blade fan, and discharged through a pipe that may be rotated in any direction to blow dust away from the combine. The drive from engine to fan includes a clutch and V-belts. In the attachment model, with fan and engine located on a trailer, the connecting circular air duct is equipped with a flexible joint, circular metal rings being used to reinforce the plastic material. A trailer hitch and spacer bar to the combine are located to keep the trailer and combine axles in alinement for proper tracking of the wheels.

PERFORMANCE

Field tests near Corvallis, Oreg., were made of the trailer unit for two seasons, and of the attachment model for one season, in both crimson clover and subterranean clover. The trailer unit was tested in areas where the discharged straw and chaff from the combine were caught by canvas and removed from the test pilot. The combine attachment model reclaimed seed material only by virtue of the nozzle location behind the header and in front of the combine discharge. Forward speeds were varied between 0.34 and 1.6 miles per hour. Chain and brush agitator speeds were varied between 170 and 700 r. p. m. Fan speed was varied between 900 and 1,500 r. p. m. The round-hole size of the rotary screen was 1/19-inch diameter.

Optimum conditions for operation of the suction reclaimer were:

	<u>Crimson clover</u>	<u>Subterranean clover</u>
Fan - 32" diam. radial blade-----	1,340 r. p. m.	1,500 r. p. m.
Air velocity at nozzle-----	3,500 r. p. m.	4,000 r. p. m.
Agitator speed: 14" diam. brush---	170 r. p. m.	250 r. p. m.
16" diam. chains--	400 r. p. m.	650 r. p. m.
Forward speed-----	0.36 m. p. h.	0.50 m. p. h.

See Diagram III, showing the schematic drive plan for the suction seed reclaimer combine attachment.

The forward speed of the attachment unit was limited by the capacity of the combine to thresh and separate both normally harvested and re-claimed portions of the crop. Forward speed of the trailer type was governed by the desired degree of recovery. Increased forward speed resulted in less recovery.

SUCTION RECLAIMER COMBINE ATTACHMENT 1957 SCHEMATIC DRIVE PLAN

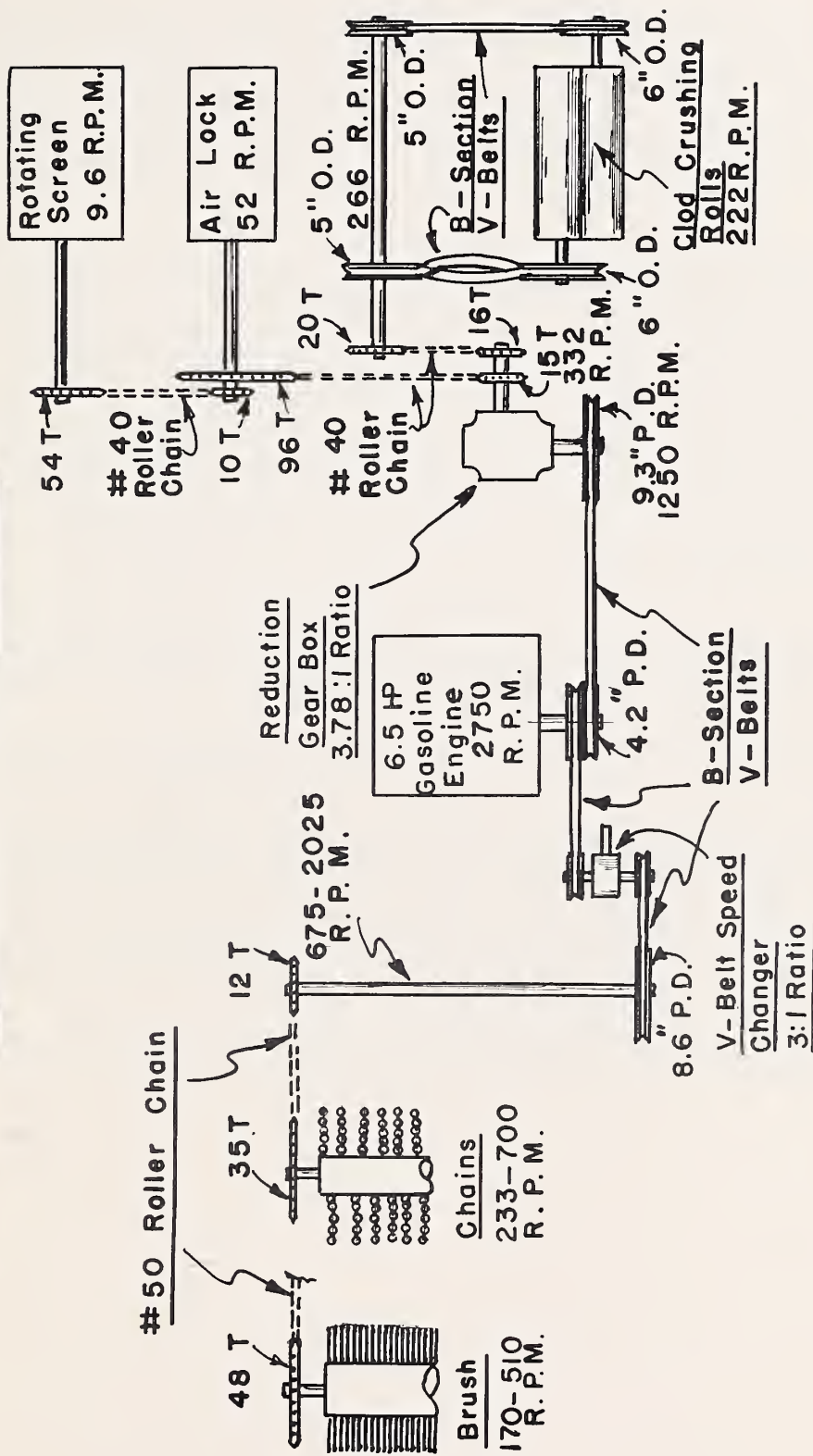


DIAGRAM III

Schematic Drive Plan showing sprocket, chain, and belt sizes and speeds for the component parts of the suction reclaimer for shattered seed.

The efficiency of recovery for shattered crimson clover seed with the trailer type machine was measured at 79 to 89 percent. For subterranean clover it was recorded at 91 to 98 percent. The average seed recovery for the combine attachment ranged from 70 to 85 percent for the two crops. The drop in efficiency shown by the unit attached to the combine is partly attributed to the longer air ducts and an alteration to the suction nozzle so that it would fit into limited space.

A comparison test between conventional harvesting and harvesting with the suction attachment was made in 1957. The conventional harvesting (mow, windrow, and combine) of crimson clover produced a combine yield of 46 percent pure live seed. Combining direct with suction attachment yielded 68 percent pure live seed in the grain bin, or a recovery of 47 percent more seed. With 420 pounds per acre representing 46 percent yield, 200 pounds per acre more pure live seed was recovered. For subterranean clover, the normal method of combining produced 24 percent pure live seed, but combining from the windrow with suction attachment increased the yield to 62 percent, or 158 percent more seed. With 503 pounds per acre representing 24 percent yield, 795 pounds per acre more pure live seed was recovered.

While no measurement of the effectiveness of the clod-crushing rolls was made, it was observed that clods were being crushed and that auxiliary air was eliminating much of the dust produced.

CONCLUSION

The operation and development work with the suction reclaimer for the past 4 years has proven that the machine will successfully retrieve shattered seed from the field in a number of small seeded crops and greatly reduce waste of valuable seed. However, the machine cannot be deemed suitable for reclaiming all shattered seed crops. For birdsfoot trefoil, for example, only 11 percent of the shattered seed was reclaimed.

Also, foreign material picked up with reclaimed seed will increase "cleaning problems."

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